GEOTECHNICAL REPORT

Orler Short Plat
12703 – 72nd Avenue NE
Kirkland, Washington

Project No. T-7313

Terra Associates, Inc.

Prepared for:

William Buchan Homes
Bellevue, Washington

February 2, 2016

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

February 2, 2016
Project No. T-7313

Mr. Greg Nelson
William Buchan Homes
2630 – 116th Avenue NE, Suite 100
Bellevue, Washington 98004

Subject: Geotechnical Report
Orler Short Plat
12703 – 72nd Avenue NE
Kirkland, Washington

Dear Mr. Nelson:

As requested, we conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

The site soils generally consist of medium dense to dense, till-like silty sand with gravel and outwash sand. Light to moderate seepage of perched groundwater was observed in two of the five exploration pits and the exploration boring between depths of about two and five feet.

In our opinion, there are no geotechnical conditions that would preclude the planned residential development. Residences can be supported on conventional spread footings bearing on competent native soils underlying the surface organic soils or on structural fill placed on the competent native soils. Floor slabs and pavements can be similarly supported.

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

John C. Sadler, L.E.G., L.H.G.
Project Manager

2-2-16

Theodore J. Schepper, P.E.
Principal

cc: Ms. Moira Haughian, Blueline

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12703 – 72nd Avenue NE
Kirkland, Washington

1.0 PROJECT DESCRIPTION

The proposed project is a residential development. Site development plans are currently not available; however, an undated conceptual site plan prepared by Blueline indicates the site will subdivided for construction of four single-family residences in the eastern portion of the site.

We expect that the residential structures would be one- to two-story, wood-frame buildings, with their main floors framed over a crawl space or constructed at grade. Foundation loads should be relatively light, in the range of 2 to 3 kips per foot for bearing walls and 25 to 50 kips for isolated columns.

The recommendations contained in the following sections of this report are preliminary and based on our understanding of the above design features. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and incorporated into project design and to amend or supplement our recommendations, if required.

2.0 SCOPE OF WORK

Our scope of work included a geologic site reconnaissance on October 30, 2015, and review of subsurface conditions and geotechnical analyses presented in a geotechnical report for the site titled *Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report*, *Orler Short Plat*, Project No. KE070837A, prepared by Associated Earth Sciences, Inc. (AESI), dated April 2, 2008.

Using the existing geotechnical data and the results of our geologic reconnaissance, analyses were undertaken to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic hazards per the City of Kirkland Zoning Code (KZC)
- Seismic design parameters per the 2012 International Building Code (IBC)
- Site preparation and grading
- Excavations
- Foundations
- Slab-on-grade floors
- Infiltration feasibility
- Subsurface drainage
- Utilities
- Pavements

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment (i.e., humidity, mildew, mold) is beyond Terra Associates' purview. A building envelope specialist or contactor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The site is an approximately 2.65-acre residential parcel located west of and adjacent to 72nd Avenue NE, approximately 730 to 950 feet south of NE 129th Street in Kirkland, Washington. A single-family residence currently occupies the eastern portion of the site. The approximate location of the site is shown on Figure 1.

The site is situated on the western margin of a glacial upland. The eastern portion of the site is relatively flat and is typically vegetated with grass lawn, landscape trees and shrubs, and scattered mature coniferous trees. The central and western portions of the site are a west-facing slope that drops moderately to steeply down into a natural drainage ravine. Surveyed topographic information for the slope is currently unavailable; however, topography shown on King County iMAP (http://www.kingcounty.gov/operations/GIS/Maps/iMAP.aspx) shows the steep slope has a vertical relief that ranges from about 40 feet near the northern site margin to about 75 feet near the southern site margin. Slope inclinations are typically about 60 to 65 percent, and flatten to about 17 percent near the toe.

We did not observe any obvious indications of deep-seated instability, persistent wet soil conditions, or groundwater seepage on the steep slope. We observed indications of localized shallow ground movement and surficial soil creep on the steeper ravine slope areas within the drainage; however, these are natural geomorphological processes that routinely occur on steep slopes in Western Washington, and in our opinion, are not an indication of deep-seated instability. Slope vegetation generally consists of mature coniferous and deciduous trees with brush undergrowth.

3.2 Soils

Review of exploration test pit and exploration test boring logs prepared by AESI indicates the site soils generally consist of about 6 to 18 inches of duff and topsoil overlying native glacial deposits comprised primarily of medium dense to dense silty sand with varying amounts of gravel, and dense, fine to medium sand with varying amounts of silt. Dense native silty sand with gravel observed to depths of about seven to nine feet in Exploration Pits EP-2 through EP-4 is interpreted to be Vashon till. Dense native sand observed throughout Exploration Pits EP-1 and EP-5, and underlying the till in Exploration Pits EP-2 through EP-4, is interpreted to be Vashon advance outwash.

Dense to very dense fine to medium sand, consistent with advance outwash, was encountered in Exploration Boring EB-1 between depths of about 20 and 70 feet. AESI has interpreted a loose to medium dense silt observed in the upper 20 feet of EB-1 to be a historical landslide block.

The *Geologic Map of the Kirkland Quadrangle, Washington,* by James P. Minard, dated 1983, shows soils underlying the upper eastern portion of the site mapped as Vashon till (Qvt). Soils underlying the slope areas in the central and western portions of the site are mapped and Vashon advance outwash (Qva). These geologic units are generally consistent with the native soils observed in the site explorations.

Logs of the test pits and test boring completed by AESI are attached in Appendix A. The approximate locations of the subsurface explorations are shown on Figure 2.

3.3 Groundwater

Light to moderate seepage of perched groundwater was observed between depths of about 2 and 3.5 feet in Exploration Pits EP-4 and EP-5, and from a localized zone about 10.5 feet below ground surface in Exploration Pit EP-4. Perched groundwater was also encountered approximately 5 feet below ground surface in Exploration Boring EB-1 during drilling.

The occurrence of shallow perched groundwater is typical for sites underlain by till and other relatively-impermeable materials. We expect that perched groundwater levels and flow rates will fluctuate seasonally and will typically reach their highest levels during and shortly following the wet winter months (October through May).

AESI installed a 1-inch diameter groundwater monitoring well to a depth of 32 feet in Exploration Boring EB-1. Field measurements made approximately two weeks following well installation found perched groundwater about 31 feet below ground surface. The groundwater at this depth appears to be perched on a silt layer observed within the advance outwash sand between depths of about 31 feet and 34 feet. The groundwater observed in the monitoring well does not appear to be related to a significant perched groundwater condition at that depth considering that wet soils were not observed in any of the samples collected below a depth of five feet.

3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards. Chapter 85.13(3) of the Kirkland Zoning Code (KZC) defines geologically hazardous areas as erosion hazard areas, landslide hazard areas, and seismic hazard areas.

3.4.1 Erosion Hazard Areas

Chapter 85.13(2) of the KZC defines erosion hazard areas as "…those areas containing soils which, according to the USDA Soil Conservation Service King County Soil Survey dated 1973, may experience severe to very severe erosion hazard. This group of soils includes, but is not limited to, the following when they occur on slopes of 15 percent or greater: Alderwood gravelly sandy loam (AgD), Kitsap silt loam (KpD), Ragnar Indianola Association (RdE) and portions of the Everett gravelly sand loams (EvD) and Indianola loamy fine sands (InD)."

The Soil Conservation Service (SCS) has mapped the soils underlying the relatively flat, eastern portion of the site as *Alderwood gravelly sandy loam, 6 to 15 percent slopes* (AgC). The slope areas in the central and western portions of the site are mapped as *Alderwood gravelly sandy loam, 15 to 30 percent slopes* (AgD). Alderwood soils are described as formed over till, which is generally consistent with the soils observed in the upper seven to nine feet of Exploration Pits EP-2 through EP-4. In our opinion, the sandy outwash soils observed in Exploration Pits EP-1 and EP-5, and underlying the slope areas in the central and western portions of the site, would be better classified as *Indianola loamy fine sand, 4 to 15 percent slopes (InC)* or *Indianola loamy fine sand, 15 to 30 percent slopes (InD)*.

According to the above criteria, site areas having surface gradients of 15 percent and steeper are considered erosion hazard areas. Based on topography shown on King County iMAP and our field observations, this would generally be limited to the sloping central and western portions of the site, outside of the planned development area.

As discussed, we did not observe indications of significant active erosion at the site; however, the site soils will be susceptible to erosion when exposed during construction. In our opinion, proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sedimentation control will adequately mitigate the erosion potential in the planned development area. All BMPs for erosion prevention and sedimentation control should conform to City of Kirkland requirements.

3.4.2 Landslide Hazard Areas

Chapter 85.13(4) of the KZC defines landslide hazard areas as both of the following:

a. High Landslide Hazard Areas – Areas sloping 40 percent or greater, areas subject to previous landslide activities, and areas sloping between 15 percent and 40 percent with zones of emergent groundwater or underlain by or embedded with impermeable silts or clays.

b. Moderate Landslide Hazard Areas – Areas sloping between 15 percent and 40 percent and underlain by relatively permeable soils consisting largely of sand and gravel or highly competent glacial till.

As discussed, we did not observe any obvious indications of deep-seated instability, persistent wet soil conditions, or groundwater seepage on the steep slope areas of the site. However, the vast majority of the slope areas in the central portion of the site have inclinations steeper than 40 percent, which meet the geometry criterion defining high landslide hazard areas. Flatter, localized slope areas meeting the criteria defining moderate landslide hazard areas exist at the top and toe of the steep slope areas. The approximate locations of the landslide hazard areas are shown on Figure 2.

AESI performed stability analysis using the computer program SLOPE/W to evaluate appropriate buffers and building setbacks from the steep slope areas. Based on the results of the analysis, AESI recommended a combined landslide hazard area buffer and building setback width of 55 feet. Based on our review, we generally concur with the analytical methodology and the results of the analysis. Provided that uncontrolled site stormwater is not directed toward or onto the steep slope areas, it is our opinion that a 55-foot wide combined buffer and building setback would adequately mitigate potential hazards associated with the landslide hazard areas at the site.

3.4.3 Seismic Hazard Areas

Chapter 85.13(5) of the KZC defines seismic hazard areas as "…those areas subject to severe risk of earthquake damage as a result of seismically induced settlement or soil liquefaction, which conditions occur in areas underlain by cohesionless soils of low density usually in association with a shallow groundwater table."

Based on our review of subsurface conditions, it is our opinion that there is no risk for liquefaction to occur at this site during an earthquake. It is also our opinion that there is little to no risk for severe damage resulting from seismically-induced settlement. Therefore, in our opinion, seismic hazard areas do not exist at the site.

3.5 Seismic Design Parameters

Based on the site soil conditions and our knowledge of the area geology, per the 2012 International Building Code (IBC), site class "C" should be used in structural design. Based on this site class, in accordance with the 2012 IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (IBC 2012)

Spectral response acceleration (Short Period), S_{Ms}	1.252g
Spectral response acceleration (1 – Second Period), S_{M1}	0.637g
Five percent damped .2 second period, S_{Ds}	0.835g
Five percent damped 1.0 second period, S_{D1}	0.425g

Values determined using the United States Geological Survey (USGS) Ground Motion Parameter Calculator accessed on January 28, 2016 at the web site http://earthquake.usgs.gov/designmaps/us/application.php.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, there are no geotechnical conditions that would preclude the planned development. Residences can be supported on conventional spread footings bearing on competent native soils underlying organic topsoil or on structural fill placed on the competent native soils. Floor slabs and pavements can be similarly supported.

Most of the near-surface, native soils contain a sufficient amount of fines (silt- and clay-sized particles) such that they will be difficult to compact as structural fill when too wet or too dry. Accordingly, the ability to use the soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections of this report. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious materials should be stripped and removed from the site. We expect surface stripping depths of about 6 to 12 inches will be required to remove the organic surficial soils from the planned development area. Stripped vegetation debris should be removed from the site. Organic soils will not be suitable for use as structural fill, but may be used for limited depths in nonstructural areas or for landscaping purposes. Demolition of existing structures should include removal of existing foundations and abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Once clearing and grubbing operations are complete, cut and fill operations to establish desired building grades can be initiated.

A representative of Terra Associates, Inc. should examine all bearing surfaces to verify that conditions encountered are as anticipated and are suitable for placement of structural fill or direct support of building and pavement elements. Our representative may request proofrolling exposed surfaces with a heavy rubber tired vehicle to determine if any isolated soft and yielding areas are present. If unstable yielding areas are observed, they should be cut to firm bearing soil and filled to grade with structural fill. If the depth of excavation to remove unstable soils is excessive, use of geotextile fabric such as Mirafi 500X or equivalent in conjunction with structural fill can be considered in order to limit the depth of removal. In general, our experience has shown that a minimum of 18 inches of clean, granular structural fill over the geotextile fabric should establish a stable bearing surface.

We anticipate that most of the near-surface, native soils contain a sufficient amount of fines (silt and clay size particles) that will make them difficult to compact as structural fill if they are too wet or too dry. Accordingly, the ability to use these soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. Soils that are too wet to properly compact could be dried by aeration during dry weather conditions, or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control (TESC) plan for the project. Soils that are dry of optimum should be moisture conditioned by controlled addition of water and blending prior to material placement.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

*Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as lower building level retaining walls, must be completed in accordance with local, state, and federal requirements. Based on the Washington State Safety and Health Administration (WSHA) regulations, the upper weathered glacial till soils and granular outwash soils would typically be classified as Type C soils. The unweathered, dense, till soils would typically be classified as Type A soils.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 or flatter. Temporary excavations in Type A soils can be laid back at inclinations of 0.75:1 or flatter. If there is insufficient room to complete the excavations in this manner, or if excavations greater than 20 feet deep are planned, you may need to use temporary shoring to support the excavations.

Groundwater seepage should be anticipated within excavations extending to the contact between the weathered and unweathered glacial till. Based on our experience, the volume of water and rate of flow into excavations should be relatively minor and would not be expected to impact the stability of the excavations when completed as described above. Conventional sump pumping procedures along with a system of collection trenches, if necessary, should be capable of maintaining a relatively dry excavation for construction purposes.

The above information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.4 Foundations

Residential structures may be supported on conventional spread footing foundations bearing on competent native soils or on structural fill placed above these native soils. Foundation subgrades should be prepared in accordance with the recommendations presented in Section 4.2 of this report. Perimeter foundations exposed to the weather should bear at a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used in design. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-fourth inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressure acting on the sides of the footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent native soil or the excavations are backfilled with structural fill, as described in Section 4.2 of this report. The recommended passive and friction values include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab and can actually serve as a water supply for moisture seeping through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained.

4.6 Infiltration Feasibility

The advance outwash sand and sand with silt observed in the exploration pits would generally be considered favorable for infiltration, or at minimum, suitable for infiltrating limited amounts of site stormwater using other natural drainage practices (NDPs). However, it is our opinion that further consideration for infiltrating site stormwater be supported by additional location-specific subsurface exploration and analysis to evaluate potential impacts of on-site infiltration to the site slopes.

4.7 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the building areas. We recommend providing a positive drainage gradient away from building perimeters. If a positive gradient cannot be provided, provisions for collection and disposal of surface water adjacent to the structures should be provided.

Surface water from developed areas must not be allowed to flow in an uncontrolled and concentrated manner over the crests of site slopes and/or embankments. Surface water should be directed away from the slope crests to a point of collection and controlled discharge. If site grades do not allow for directing surface water away from the slopes, then the water should be collected and tightlined to an approved point of controlled discharge.

Subsurface

We recommend installing a continuous drain along the outside lower edge of the perimeter building foundations. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe that is enveloped in washed ½- to ¾-inch gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. The foundation drains and roof downspouts should be tightlined separately to an approved point of controlled discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once each year.

4.8 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or local jurisdictional requirements. At minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. We anticipate that the on-site soils would generally be suitable for use as backfill material. However, the vast majority of the site soils are fine grained and moisture sensitive; therefore, moisture conditioning may be necessary to facilitate proper compaction. If utility construction takes place during the winter, it may be necessary to import suitable wet weather fill for utility trench backfilling.

4.9 Pavements

Pavements should be constructed on subgrades prepared as recommended in Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. Proofrolling the subgrade with heavy construction equipment should be completed to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For traffic consisting mainly of light passenger vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of hot mix asphalt (HMA) over four inches of crushed rock base (CRB)
- 3 ½ inches full depth HMA over prepared subgrade

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction in order to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Orler Short Plat project in Kirkland, Washington. This report is for the exclusive use of William Buchan Homes and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based on site-specific subsurface data presented in the AESI report. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.

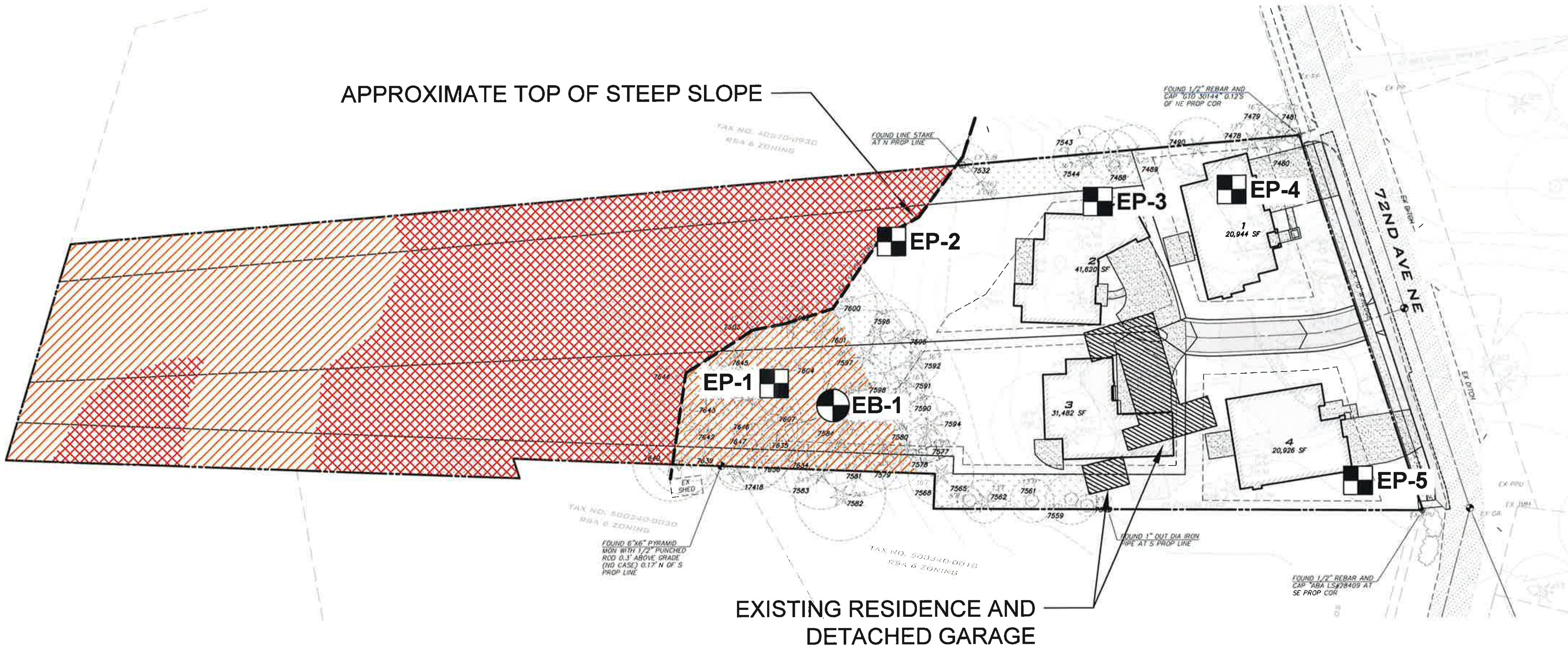
REFERENCE: THOMAS GUIDE (2008)

NOT TO SCALE

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
ORLER SHORT PLAT
KIRKLAND, WASHINGTON

Proj. No.T-7313	Date FEB 2016	Figure 1



0 60 120

APPROXIMATE SCALE IN FEET

NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:

SITE PLAN BY BLUELINE

LEGEND:

- APPROXIMATE TEST PIT LOCATION (AESI 2008)
- APPROXIMATE BORING LOCATION (AESI 2008)
- APPROXIMATE HIGH LANDSLIDE HAZARD AREA PER KZC
- APPROXIMATE MODERATE LANDSLIDE HAZARD AERA PER KZC

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EXPLORATION LOCATION PLAN
ORLER SHORT PLAT
KIRKLAND, WASHINGTON

Proj. No.T-7313	Date FEB 2016	Figure 2

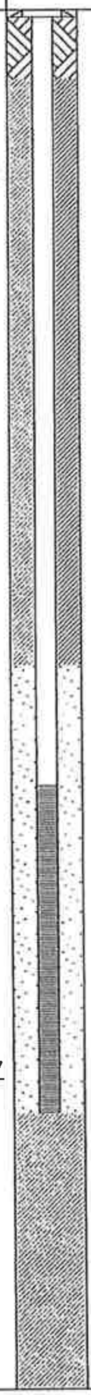
APPENDIX A

TEST BORING AND TEST PIT LOGS BY OTHERS

Associated Earth Sciences, Inc.	Geologic & Monitoring Well Construction Log		
	Project Number KE070837A	Well Number EB-1	Sheet 1 of 2

Project Name: Orler Short Plat
Elevation (Top of Well Casing): ~372 feet
Water Level Elevation:
Drilling/Equipment: Bortech/Track
Hammer Weight/Drop: 140# / 30"

Location: King County, WA
Surface Elevation (ft): ~372 feet (not surveyed)
Date Start/Finish: 2/25/08,2/25/08
Hole Diameter (in): 6"



Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Aboveground monument Grout/cement 0 to 2 feet				**Landslide Block**
5	▼	1-inch piezometer set to 32 feet		4 2 4		Very moist to wet, brown, highly mottled, SILT, with fine SAND, weakly laminated with organics and charcoal. Perched seepage zone.
10		Bentonite 2 to 19 feet		5 7 13		Very moist, brown, massive, SILT, with very fine sand, trace organics, slickensides present.
15				5 7 11		Moist, brown, SILT, with fine to medium sand seams to 1/2-inch thick, also contains sand dikes 1/2-inch thick and trace organics, otherwise massive.
				8 12 16		Moist, gray-brown, SILT, with subvertical stratified sand against horizontal laminated silt and clasts of charcoal or peat, also fine, horizontally bedded, oxidized sand seams to 2 mm thick.
20		Sand 19 to 32 feet		19 20 19		**Vashon Advance Outwash** Moist, brown, silty fine to medium SAND, little gravel and silt lenses to 2 inches thick, sand is massive (unstratified).
				20 20 26		Moist, brown, fine to medium SAND, trace silt, massive, trace gravel (cuttings), trace silty sand lenses to 1 inch thick.
25		Screen 22.5 to 32 feet		13 20 17		Moist, brown, interbedded SILT and SAND, with silt, few gravel; silt is laminated.
				18 37 45		Moist, brown, fine to medium SAND, with trace silt, little fine gravel, massive, few silty sand lenses to 1 inch thick (trace charcoal?), silt is laminated.
30	▽			21 50/5"		Moist, brown, fine to medium SAND, trace silt and gravel, gravels reported by driller.
				13 18 29		Dry, gray-brown, SILT, laminated with traces of organics, sand lens at 34 feet, 3 inches thick (no silt).
35				13 15 21		Moist, gray-brown, fine to medium SAND, trace silt and coarse sand, weakly stratified.
				24 36 47		Moist, gray-brown, fine to medium SAND, trace silt, few lenses of silt to 1/2 inch thick, with gravel weakly stratified.

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
▽ Water Level (3/11/08)
▼ Water Level at time of drilling (ATD)

Logged by: SGB
Approved by:

Associated Earth Sciences, Inc.

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
KE070837A	EB-1	2 of 2

Project Name: Orler Short Plat
Elevation (Top of Well Casing): ~372 feet
Water Level Elevation:
Drilling/Equipment: Bortech/Track
Hammer Weight/Drop: 140# / 30"

Location: King County, WA
Surface Elevation (ft): ~372 feet (not surveyed)
Date Start/Finish: 2/25/08,2/25/08
Hole Diameter (in): 6"

Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
				35 29 40		Moist, gray-brown, fine to medium SAND, with gravel, trace silt, weakly stratified.
				18 23 25		Same.
45		Bentonite 32 to 75 feet		16 18 24		Moist, gray-brown, fine to medium SAND, little gravel, trace silt, very weakly stratified to massive.
				23 30 35		Gravel reported by driller. Same as above.
50				26 43 45		No longer stratified - massive.
				23 25 32		Contains few silt inclusions faintly stratified.
55				31 30 29		Moist, gray-brown, medium to coarse SAND grading to fine to medium SAND, trace silt and gravel.
				20 22 31		Moist, gray-brown, fine to medium SAND grading to fine SAND, massive, trace silt and gravel.
60				22 33 32		Moist, gray-brown, fine SAND, trace silt, massive.
				24 28 39		Moist, gray-brown, fine to medium SAND, trace silt, massive.
65				28 31 48		Moist, gray-brown, fine to medium SAND, trace silt and gravel, weakly stratified.
				50/5.5"		Gray-brown, silty SAND, with gravel.
70				18 35 41		**Pre-Fraser Fine-Grained Deposits** Dry, light gray, SILT, interbedded with fine sand, trace silt (silt is highly laminated, sand is weakly stratified and contains peat lenses).
				21 26 31		Dry to moist, gray-brown, fine SAND, trace silt and lens of dry silt (laminated) at 72.5 feet.
75				25 29 36		Moist, gray, fine to medium SAND, trace silt, weakly stratified, with traces of silt lenses to 2 mm thick.
						Boring terminated at 76.5 feet on 2/25/08 Waited at BOH (-6 inches) for 15 minutes. Rods and sampler completely dry when pulled up. Cuttings saturated likely from seepage zone at ~5 feet.

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level (3/11/08)
Water Level at time of drilling (ATD)

Logged by: SGB
Approved by:

LOG OF EXPLORATION PIT NO. EP-1

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil/Forest Duff
1	Medium dense, moist, dark brown, silty fine to medium SAND, little to few medium to coarse sand; organic rich, highly oxidized.
	Weathered Vashon Advance Outwash
2	Medium dense, moist, orange-brown, silty fine SAND, trace medium to coarse sand, occasional fine gravel; oxidation forming mottled texture, minor roots present.
3	
4	
5	**Vashon Advance Outwash**
6	Dense, moist, light gray-brown, silty fine SAND.
7	
8	
9	
10	
11	0.5- to 1-inch fine to coarse SAND seams appear every 6 inches.
12	
13	
14	
15	1- to 3-inch highly oxidized fine to coarse SAND seam with 1 to 5 mm oxidized SILT seams up to 2 inches below sand.
16	Dense, moist, light brown-gray, fine to coarse SAND, few silt, interbedded with silty fine SAND, few medium to coarse sand, few fine to coarse gravel; coarse sand and gravel are dropstones in the silt.
17	Bottom of exploration pit at depth 16.5 feet No seepage. No caving.
18	
19	
20	

Orler Short Plat
King County, WA

Associated Earth Sciences, Inc.

Logged by: ALD
Approved by:

Project No. KE070837A
1/16/08

KCTP3 070837A.GPJ March 12, 2008

LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
1	**Forest Duff/Topsoil** Loose, moist, dark brown, silty fine to coarse SAND, few fine to coarse gravel; organic rich, abundant roots.
2–5	**Fill or Colluvium** Loose to medium dense, moist to very moist, orange-brown, silty fine to medium SAND, with coarse sand, little fine to coarse gravel; moderate caving, occasional organics, oxidized, unsorted. Becomes unoxodized and gray-brown.
6–9	**Vashon Lodgement Till** Dense, moist, gray-brown, silty fine SAND, little medium to coarse sand, few fine to coarse gravel; unsorted.
10–16	**Vashon Advance Outwash** Dense, moist, brown, silty fine SAND, trace medium sand; massive.
17–20	Bottom of exploration pit at depth 16 feet No seepage. Moderate caving 0 to 5.5 feet.

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1/16/08

LOG OF EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
0–1	**Forest Duff/Topsoil** Medium dense, moist, dark brown, silty fine to coarse SAND, few fine to coarse gravel; organic rich, abundant roots.
1–3.5	**Weathered Vashon Lodgement Till** Medium dense to dense, moist, brown, silty fine to medium SAND, little coarse sand, few fine to coarse gravel; oxidized, minor roots present.
3.5–7	**Vashon Lodgement Till** Dense, moist, gray-brown, silty fine SAND, little to few medium to coarse sand, few fine to coarse gravel; unsorted.
7–15	**Vashon Advance Outwash** Dense, moist, brown, silty fine SAND, trace medium sand.
11	Dense, moist, light gray-brown, silty fine SAND, with medium to coarse sand, few fine to coarse gravel; gravel dropstones present.
14	Dense, moist, gray-brown, silty fine to medium SAND, little coarse sand, few fine to coarse gravel; gravel dropstones present.
15	Bottom of exploration pit at depth 15 feet No seepage. No caving.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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Project No. KE070837A
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KCTP3 070837A.GPJ March 12, 2008

LOG OF EXPLORATION PIT NO. EP-4

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Forest Duff/Topsoil
1	Medium dense, moist, dark brown, silty fine to coarse SAND, few fine to coarse gravel; organic rich, abundant roots.
	Weathered Vashon Lodgement Till
2	Medium dense to dense, moist, yellowish brown, silty fine to coarse SAND, few fine to coarse gravel; oxidized, minor roots present, unsorted.
3	
	Vashon Lodgement Till
4	Dense, moist, gray-brown, silty fine SAND, with medium to coarse sand, little to few fine to coarse gravel; unsorted.
5	
6	
7	
	Vashon Advance Outwash
8	Dense, moist to wet, brown, fine to coarse SAND, with to little silt, little to few fine to coarse gravel.
9	
10	Silt content reduces slightly and moderate seepage encountered.
11	
12	Dense, moist, brown, silty fine SAND, few fine to coarse gravel, few to trace medium to coarse sand; gravel dropstones present (looks like a diamict).
13	
14	Bottom of exploration pit at depth 13 feet Minor seepage (~1 gpm) at 3.5 feet. Moderate seepage (2 to 4 gpm) at 10.5 to 11 feet. No caving.
15	
16	
17	
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19	
20	

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LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.
	Forest Duff/Topsoil
	Weathered Vashon Advance Outwash
1	Medium dense, moist to wet, orange-brown, medium to coarse SAND, little fine sand, few fine to coarse gravel, few silt; oxidized, minor roots present.
2	
	Vashon Advance Outwash
3	Dense, moist, brown, medium to coarse SAND, little fine sand, few to trace fine to coarse gravel; stratified, somewhat cemented.
4	
5	
6	Dense, moist, brown, silty fine SAND; massive to very faint lamination.
7	
8	
9	
10	
11	
12	Bottom of exploration pit at depth 11 feet Moderate seepage (2 to 4 gpm) at 2 to 2.5 feet. No caving.
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14	
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19	
20	

KCTP3 070837A.GPJ March 12, 2008

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1/16/08